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APPLIED MANUFACTURING RESEARCH

DEPARTMENT 190-2

EVALUATION OF NEW MANUFACTURING PROCESSES AND TECHNIQUES

FINAL REPORT

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CONVAIR
A Division of General Dynamics Corporation
(San Diego)

Convair-San Diego

EVALUATION OF NEW MANUFACTURING PROCESSES AND TECHNIQUES

ABSTRACT

A number of Convair-San Diego production problems are outlined. Facilities which were investigated in an effort to solve the problems are listed with the evaluation and action taken by Convair.

Cost of project: $6,500.00 (Estimate)

Convair-San Diego

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1. PROJECT TITLE: Evaluation of New Manufacturing Processes and Techniques.

2. STATEMENT OF PROBLEM:

The results of millions of dollars spent annually by the Government and the airframe industry in developing new manufacturing processes and techniques are not always reported, or if so, not analysed in time to effect utilization in current programs at Convair-San Diego.

3. OBJECTIVE:

(1) To investigate latest techniques and facilities used by other manufacturers in the solution of selected current or potential production problems.

(2) To set up a controlled experiment, if necessary, to varify the results of investigations and to incorporate beneficial results into production or future planning.

4. PURPOSE:

To take early advantages of manufacturing improvements, avoid duplication of efforts and reduce costs.

5. CONCLUSION AND RECOMMENDATION:

See paragraph 6 for the evaluation and action taken on each problem.

6. DEVELOPMENT OF PROJECT:

6.1 Problem: In our present practice, corrosion is frequently encountered on barrel finished parts that have been hand dried by forced air blowing.

6.1.1 Facilities Investigated: (Ref. 7.1)

(1) A heated barrel type rotary drier with corn husk and cob drying powder - Convair-Pomona.

6. DEVELOPMENT OF PROJECT:

6.1.1 Facilities Investigated: (Cont'd)

(2) A heated barrel type rotary drier with saw dust drying media. Colormatic Sales Co., Gardena, California.

6.1.2 Evaluation: The heated barrel type rotary drier, using either saw dust or corn cob drying compounds, eliminates the corrosion problem.

6.1.3 Action Taken: A written recommendation was submitted to Department 8, to request a heated rotary drying unit for Department 115 Capital Budget. The recommendation was in support of a Department 115 request.

6.2 Problem: Burrs are difficult to remove from inaccessible small passageways and internal blind holes.

6.2.1 Facilities Investigated: (Ref. 7.1)

(1) Dynamic Internal Hone - Designed and developed by Convair-Pomona.

(2) "Back-burring" machine at Convair-Pomona.

6.2.2 Evaluation: Both machines perform satisfactorily, but Dynamic Internal Hone is applicable to almost all tasks, while "back-burring" is applicable essentially to drilled holes.

6.2.3 Action Taken: Convair-San Diego, at present, does not have enough applications to warrant capital expenditure. If and when demand supports procurement, the Dynamic Internal Hone is recommended for versatility advantages.

6. DEVELOPMENT OF PROJECT: (Cont'd)

6.3 Problem: Convair is unable to make 2D or less bends in thin walled high strength tubing.

6.3.1 Facilities Investigated: (Ref. 7.2)

(1) Kilsby Tube Supply - Los Angeles.

(2) Aeroquip Mfg. Corporation - Los Angeles.

6.3.2 Evaluation: Bending of high strength tubing has not been sufficiently developed at the facilities investigated. However, a unique method of bending 1 inch diameter aluminum tubing to 2 inch diameter bends, using rubber mandrels, was inspected.

6.3.3 Action Taken: A Project Request is in preparation to evaluate the rubber mandrel method of bending aluminum.

6.4 Problem: Excessive hand finishing of detail parts lends to a high-cost, low-quality end product.

6.4.1 Facilities Investigated: (Ref. 7.3)

The Fort Worth facility has expended considerable effort on this problem. A trip was, therefore, made to observe and evaluate the work accomplished by their program.

6.4.2 Evaluation: Fort Worth attacked the problem in three steps, as follows:

(1) Surveyed all hand finish operations and then acquainted the factory inspection, tooling and engineering personnel with their findings.

(2) Engineering reviewed all drawings for consistency of finish and deburring requirements, and then determined

6. DEVELOPMENT OF PROJECT:

6.4.2 Evaluation: (Cont'd)

(2) whether all requirements were necessary and realistic. Planning reviewed operational planning and determined whether all deburr operations were really necessary in order to reflect engineering requirements.

(3) The third course of action was to determine and put to use the most economical method of deburring, breaking corners or blending, consistent with requirements and peculiarities of each part. Present methods of deburring and blending are as follows:

Barrel finish	Sand blast
Chemical etch	Hand finish and hand deburr.

Fort Worth makes every effort to use barrel finish to the fullest extent.

After analyzing corner breaks of 0.015" as specified by Engineering drawing, Fort Worth allowed corner breaks of 0.005" to 0.025", which would be within a drawing tolerance of $\pm$ 0.010". A three minute immersion of aluminum parts in a chemical etch solution would produce a 0.005" corner break. Chemical etch also performed satisfactorily for blending machined surfaces. Large machined aluminum bulkheads, spar caps and machined fittings of all kinds were satisfactorily deburred by chemical etch.

Sandblast deburring did not prove satisfactory in most cases.

6. DEVELOPMENT OF PROJECT: (Cont'd)

6.4.3 Action Taken:

(1) A similar attack to that employed by Fort Worth is being conducted at the San Diego Division in reducing deburring costs. A reduction of 6 men in the deburring area has been effected by substituting barrel finishing.

(2) Additional equipment, including a heated barrel tumbler drier and a mechanical belt sanding machine, has been included in the 1961 Capital Budget.

(3) Continuing coordination with Fort Worth was scheduled to take mutual advantages of the developments of both Divisions.

6.5 Problem: No successful technique for brazing honeycomb sandwich panels has been developed at Convair-San Diego.

6.5.1 Facility Investigated: (Ref. 7.3)

An electric blanket brazing process at Convair-Fort Worth.

6.5.2 Evaluation: An excellent curved production panel has been brazed by this method in the Fort Worth pilot shop. The arrangement consists of a Glasrock reference plane tool on one side only, strip heaters, the Fort Worth Kamer type braze box, a steel air pressure bag and a restraining cover. To accelerate cool down, an air chamber of masonite was bonded to the lower side

6. DEVELOPMENT OF PROJECT:

6.5.2 Evaluation: (Cont'd)

of the Glasrock reference plane, which had air passages through the tool to grooves on the face next to the braze box. A relatively inexpensive electrical power supply and control is required to operate brazing systems of this type.

6.5.3 Action Taken: Fort Worth report #FMR 4-251 was obtained and submitted for further evaluation, for possible future applications.

6.6 Problem: The quenching phase of aluminum heat-treatment causes erratic distortion which necessitates extensive hand straightening on some parts to make them acceptable for use.

6.6.1 Facilities Investigated: (Ref. 7.4)

The following aluminum heat-treat facilities were visited:

Ryan Aeronautical Corporation - San Diego
Rohr Aircraft - Chula Vista
Lockheed Aircraft - Burbank
Production Heat-treating Co. - Hollywood
North American Aviation - El Segundo
Douglas Aircraft - El Segundo
Quality Aluminum Heat-treating Co. - El Segundo
South. Calif. Aluminum Heat-treating Co. - Vernon
Aluminum Alloy Treating Co. - Vernon
Aero Aluminum Treating - Vernon

6.6.2 Evaluation: In order to keep hand straightening at a minimum, the following practices should be maintained as much as production facilities and production loads warrants. These practices represent the consensus of opinions of Convair, and of the aluminum heat-treat processors contacted.

6. DEVELOPMENT OF PROJECT:

6.6.2 Evaluation: (Cont'd)

(1) During the forming of parts, relatively high pressure equipment should be employed to obtain 5000 to 7500 psi forming pressures.

(2) Use salt bath for heat-treating all finished formed parts with the exception of 6061 material.

(3) Where quantity warrants, use air furnaces and spray quench for 6061 material.

(4) Hand quench parts where configuration is conducive to warpage during rack or free fall quench.

(5) Where free fall quenching is used, a drop of one to four feet produces the most satisfactory parts. (Many hand quench operations are in the free fall category.)

(6) Use air furnaces for parts which are to be worked by re-strike or stretch.

(7) Maintain quench water under 90°F.

(8) Dip quench parts in a solution (3 parts kerosene to 1 part trichlorethylene) at -20 to -40°F immediately after water quenching and before refrigeration. (The relatively softer material that results, reduces hand straightening time.)

(9) Proper racking is of the utmost importance.

a. Long and relatively narrow parts should be racked in a vertical position, or as nearly

6. DEVELOPMENT OF PROJECT:

6.6.2 Evaluation: (Cont'd)

(9) a. vertical as the length will permit.

b. Parts entering the quench water should do so in a manner producing a minimum of resistance.

c. Rack parts to obtain maximum air circulation in the furnace and water circulation when entering the quench water.

d. Heat-treat operators must be trained to rack parts to reduce distortion from the weight of the part during the heating cycle and from the water impact forces during the quenching.

e. If a part distorts during heat-treatment, it should be analyzed to determine the correct racking.

f. The heat-treat operator must be flexible and have the desire to change the racking as required to prevent or reduce distortion.

g. An active inspection is required to insure that proper racking is achieved.

(10) Equip air furnace racks with double screen floors, the bottom rack approximately 1-1/2" mesh, 2" to 4" below a second rack of approximately 3/4" mesh. The screens "diffuse" the water, reducing the impact of the parts as they strike the water during quenching, thereby reducing warpage.

6. DEVELOPMENT OF PROJECT:

6.6.2 Evaluation: (Cont'd)

(11) Hand straightening methods should be reviewed with the aim of reducing lost motion and obtaining the greatest amounts of production from each straightening operation.

(12) Engineering requirements should be reviewed to determine if straightness requirements could be relaxed. It is possible that in many instances, requirements are more severe than the application actually demands.

6.6.3 Action Taken:

(1) A Verson Wheelon 6500 psi press is included in the 1961 Capital Budget Brochure for Plant 1. This is in consideration of evaluation of item one, paragraph 6.6.2.

(2) A recommendation was submitted to the responsible supervision to consider increasing the size of the salt bath, to increase our salt bath heat treat capabilities.

(3) A project is currently in progress to evaluate dip quenching parts to sub-zero temperatures immediately after water quenching and prior to normal refrigeration. This project is also evaluating double screen floors for rack quenching.

(4) Racking procedures have been reviewed. New racks

6. DEVELOPMENT OF PROJECT:

6.6.3 Action Taken: (Cont'd)

(4) have been installed and efforts to rack parts to conform with the best techniques are being followed. A recommendation has been made and drawings have been obtained to include illustrations of recommended racking and handling of parts during quenching in the M.P.S. on aluminum solution heat-treatment.

6.7 Problem: Recent developments in the high energy forming field at Fort Worth have not been assimilated to supplement Convair-San Diego's high energy forming development.

6.7.1 Facility Investigated: Convair-Fort Worth (Ref. 7.5).

6.7.2 Evaluation:

Dynapak development is currently centered around determining the ram speed. This is done by tracing the progress of the advancing ram on a constant speed circulating graph from which milisecond time increments show the ram advance. The graphic results can be readily analyzed and the ram speed calculated. The resulting data is being used to gain more knowledge of the mechanics of tension crack formation, which develops in the extrusion process.

Some tubular production work is conducted by the Fort Worth Hi-Vo-Pak facility. Forming, trimming and piercing is conducted in a single operation essentially free of burrs. The parts formed are for the B-58 aircraft.

6. DEVELOPMENT OF PROJECT: (Cont'd)

6.7.3 Action Taken: Convair-San Diego has some similar parts used on the present production aircraft which are being studied in the light of the Fort Worth developments.

6.8 Problem: The Kodak Masking Process has not been evaluated as a possible capital investment to supplement chemical milling at Convair-San Diego.

6.8.1 Facility Investigated: Convair-Fort Worth. (Ref. 7.6)

6.8.2 Evaluation: Kodak Metal Etch Resist has proven unsatisfactory at the present state of development. To date, only small 4" x 6" panels have been masked with any degree of success. These panels were made at Eastman Kodak Co. Fort Worth work on larger panels was unsatisfactory. Pin holes in the maskants and lint dust which reacted with the etchants allowed the etchant to pit the metal under the maskants. Extensive development work is still required before the process can be applied to production work. Practically no work has been conducted on complex curvature components, in which field the Kodak method would offer the greatest potential.

6.8.3 Action Taken: It was recommended that no capital expenditure be made at this time because the process is insufficiently developed. It was estimated that even a crash program could not advance this development to a point of expenditure before the next fiscal year.

6. DEVELOPMENT OF PROJECT: (Cont'd)

6.9 Problem: Convair-San Diego has not utilized the solutions of industry-wide problems presented at Technical Society Conventions.

6.9.1 Facilities Investigated: SAE Convention in Los Angeles. (Ref. 7.7)

6.9.2 Evaluation: From paper presentations attended at the convention, the following potential proposals are under consideration:

(1) Use of titanium backup bars for fusion welding to help obtain a narrow weld bead with good uniformity and less workpiece distortion.

(2) Use of B.O.B. Chevron joints for thin gauge metal fusion welding. This type joint is self-aligning and has a uniform burn-down which permits better arc control.

(3) Use of a super cooled torch and backup gas to help refine the grain structure in the weld zone. Argon is passed through liquid nitrogen and reaches the workpiece at about -130°F.

(4) The successful fusion welding of foil metals depends in part, on the thermodynamic properties of the welding arc. Variations in work hardening of certain stainless steels, surface scale, height of burn-down flanges, power input and general non-uniformity of the metal cause arc wandering. These effects should be studied quantitatively.

6. <u>DEVELOPMENT OF PROJECT:</u> (Cont'd)

6.9.2 <u>Evaluation:</u>

(5) Foil seem welding - a rapid method of butt welding on a seam welder.

(6) Forming of refractory metals in inert atmospheres.

(7) Development of low cost, see through, plastic inert gas fusion welding chambers.

(8) Evaluation of methods of lot segregation of refractory metals to be used for forming.

(9) Development of hot-riveting of refractory metals.

(10) Evaluate effect of forming conditions on refractory metals (stressed vs. non-stressed, notch sensitivity, temperature, etc.).

(11) Evaluate use of titanium and refractory metal alloys as high temperature brazing materials for induction vacuum brazing dissimilar refractory metals.

6.9.3 <u>Action Taken:</u> To date, Project Requests have been prepared to further develop items 6.9.2 - ([illegible]), ([illegible]), ([illegible]) and ([illegible]).

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7.5 J. F. Murphy to A. P. Langlois, 26 August 1960; Trip Report to Fort Worth.

7.6 L. J. Mattek to S. Leith, 20 October 1960; Trip Report to Convair-Fort Worth, 12-14 October 1960.

7.7 E. Vermilyea, W. Carr, J. Lederer and G. Bradbury to S. Leith, 18 October 1960; Trip Report to Los Angeles, SAE Convention.